

Zoeal Stages of Fat-Handed Snapping Shrimp *Synalpheus tumidomanus* (Decapoda: Caridea: Alpheidae) Reared in the Laboratory

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ABSTRACT

The first three zoeal stages of fat-handed snapping shrimp *Synalpheus tumidomanus* (Paulson, 1875) are described and illustrated in detail based on laboratory-reared material. Morphological comparison is made with previous description of *S. tumidomanus* from Indian waters. Three segmented scale of the antenna and the length of the endopod of antenna readily distinguish the first zoeas of *S. tumidomanus* from those of *S. neomeris*, the other known species of the genus *Synalpheus* from Korea.

Key words: zoeas, *S. tumidomanus*, Alpheidae

INTRODUCTION

The Korean Alpheidae contains presently eight genera (*Alpheus*, *Athanas*, *Automate*, *Betaeus*, *Prionalphes*, *Salmonaeus*, *Stenalphops*, and *Synalpheus*). There are two species of the genus *Synalpheus* from Korean waters: *Synalpheus neomeris* (De Man, 1897) and *Synalpheus tumidomanus* (Paulson, 1875) (see Kim and Moon, 1994; Koo and Kim, 2003). The fat-handed snapping shrimp *S. tumidomanus* inhabits bryozoans, dead coral, sponges, and sea weeds, and it is known to occur in the Mediterranean coast of Israel and Red Sea to South Africa, Korea, eastward to Japan, Philippines, Indonesia, Australia, and across the Pacific to Phoenix Islands (Chace, 1988; Kim and Moon, 1994).

Gurney (1927) described the first zoeas of *S. neomeris* under the name of *Synalpheus gravieri*, based on plankton materials collected from Suez Canal. Bhuti et al. (1977) described the first three zoeal stages of *S. tumidomanus* hatched from ovigerous female collected from Kavar, western India. The illustration of the zoeal appendages given by Bhuti et al. (1977) is, however, somewhat inadequate. The purpose of the present study is to describe and illustrate the zoeal stages of *S. tumidomanus* in detail, and to compare the first zoeas of *S. tumidomanus* with those of *S. neomeris*, the other known species of *Synalpheus* from Korea.

MATERIALS AND METHODS

In July 1998, ovigerous female of *Synalpheus tumidomanus*

was collected from Geojedo Island, southern Korea. In the laboratory, it was maintained in 2 L glass beaker, containing well-aerated natural seawater until hatching occurred. The female released 17 first zoeas on 28 July 1998. Newly hatched zoeas were reared individually in Corning twelve tissue culture plates, ranging in volume from 6 to 8 mL per well of aerated seawater of 33.3‰ in a growth chamber at 25°C. Larvae were fed with newly hatched *Artemia* nauplii and transferred daily to newly prepared culture plates. Some specimens in each stage were preserved in 5% neutral formalin solution for later examination. Measurements and setal counts were based on four specimens for each zoeal stage. Dissected appendages were examined using a Nikon FXII microscope, and drawings were made with the aid of a camera lucida. Body length (BL) was determined from the postorbital margin to the posteromedian margin of the telson, excluding posterior setae. Carapace length (CL) was determined from the postorbital margin to the posteromedian margin of the carapace. The setal armature of the appendages is described from proximal segment towards distal segment. The chromatophore pattern was determined by observing living larvae.

RESULTS

Four zoeal stages were obtained. However, the fourth zoeal stage could not be described and illustrated, because only two zoeas were obtained. The first zoeal stage is described in detail. For the subsequent stages, only the main differences from the previous stage are given.

Synalpheus tumidomanus (Paulson, 1875)

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First zoea (Fig. 1)

Duration. 18-20 hours.

BL. 1.87-1.90 mm (1.88 mm); CL. 0.62-0.65 mm (0.63 mm).

Carapace (Fig. 1A). Rostrum absent; anterior dorsomedian papilla present; supraorbital and antennal spines absent; anteroventral and posteroventral denticles absent; eyes sessile.

Antennule (Fig. 1B). Peduncle 2-segmented, with long plumose seta; inner flagellum not differentiated; outer flagellum with 3 aesthetascs and plumose seta.

Antenna (Fig. 1C). Peduncle with spine; endopod rod-like, 0.5 of scale, with 2 distal plumose setae; scale 3-segmented, with 11 plumose setae, and distolateral tooth.

Mandibles (Fig. 1D). Rudimentary; palps (not shown) absent; left mandible with *lacinia mobilis* between incisor and molar processes; right mandible (not shown) with spine at corresponding site.

Maxillule (Fig. 1E). Coxal endite with 2 distal setae; basal endite with 3 stout spines; endopod segmented, with 2 distal setae.

Maxilla (Fig. 1F). Coxal endite with 3 setae; basal endite bilobed, with 2+4 setae; endopod bilobed, with 2+3 setae; scaphognathite with 5 (1 proximal, 1 medial, 3 distal) plumose setae.

First maxilliped (Fig. 1G). Coxa unarmed; basis with 4 spiniform setae and 3 setae; endopod segmented, with basal seta, 3 distal setae; exopod with 4 distal plumose natatory setae, distal setae symmetrically disposed in 2 pairs.

Second maxilliped (Fig. 1H). Coxa and basis unarmed; endopod 4-segmented, with 0, 0, 1, 2+1 setae, distal spine present; exopod with subdistal seta and 4 distal plumose natatory setae, distal setae symmetrically disposed in 2 pairs.

Third maxilliped (Fig. 1I). Coxa and basis unarmed; endopod slightly longer than exopod, 1.04 of exopod, 5-segmented, with 0, 0, 0, 2, 2 setae, distal spine present; exopod 2-segmented, with 2,4 plumose natatory setae, 4 distal setae symmetrically disposed in 2 pairs.

Pereopods (Fig. 1J). First pereopod present as biramous bud, both rami elongate; second pereopod present as uniramous bud; fifth pereopod present as uniramous bud, elongate; third and fourth pereopods not differentiated.

Abdomen (Fig. 1A). Composed of 5 somites; sixth abdominal somite not differentiated; all somites without spines; pleopods absent.

Telson and uropods (Fig. 1K). Telson rounded, with shallow posteromedian concavity; posterior margin with 7+7 plumose setae; outermost 2 pairs plumose only on innerside; base of all setae with row of minute spinules; uropods present as uniramous bud.

Chromatophores (Fig. 1A). Red chromatophores present on superolateral margin of each eye, dorsally on carapace,

junction of thorax and abdominal somites, and dorsally on first to fifth and last abdominal somites. Yellow chromatophores present on mandibles, peduncle and endopod of antenna, bases of first and third maxillipeds, endopods of second and third maxillipeds, lateral margin of carapace, and laterally on first to fifth and last abdominal somites. Orange chromatophores present laterally on carapace.

Interspersion of yellow among red chromatophores present on peduncle and outer flagellum of antennule, and telson.

Second zoea (Fig. 2)

Duration. 1-2 days.

BL. 1.97-2.00 mm (1.99 mm); CL. 0.74-0.77 mm (0.75 mm).

Carapace (Fig. 2A, B). Rostrum broad proximally, pointed, falling short of distal margins of eyes, with dorsomedian seta; carapace with 2 dorsomedian setae; eyes stalked.

Antennule (Fig. 2C). Peduncle incompletely 3-segmented, with 4, 2, 7 plumose setae; inner flagellum with long plumose seta; outer flagellum with 5 aesthetascs, simple seta, and plumose seta.

Antenna (Fig. 2D). Endopod 0.65 of scale, with 3 distal plumose setae.

Mandibles. Unchanged.

Maxillule (Fig. 2E). Coxal endite with 6 distal setae; basal endite with subdistal seta and 4 distal plumodenticulate setae.

Maxilla (Fig. 2F). Proximal lobe of basal endite with 4 setae; scaphognathite with proximal seta and 4 distal plumose setae.

First maxilliped (Fig. 2G). Coxa with 2 setae.

Second maxilliped (Fig. 2H). Basis with seta; endopod with 0, 0, 1, 3+1 setae.

Third maxilliped (Fig. 2I). Basis with 2 setae; endopod 1.16 of exopod.

Pereopods (Fig. 2J). Second pereopod biramous, both rami elongate; third pereopod present as biramous bud.

Abdomen (Fig. 2A). Fifth abdominal somite with pair of dorsomedian setae; pleuron with pair of minute posteroventral spines.

Telson and uropods (Fig. 2K). Telson with 8+8 marginal setae; outermost pair plumose only on inner side. Uropods unchanged.

Third zoea (Fig. 3)

Duration. 2-3 days.

BL. 2.95-2.99 mm (2.97 mm); CL. 0.95-0.98 mm (0.97 mm).

Carapace (Fig. 3A, B). Unchanged.

Antennule (Fig. 3C). Peduncle with 9, 7, 9 plumose setae; inner flagellum with 2 distal setae; outer flagellum with 5 aesthetascs, simple seta, and subterminal plumose seta.

Antenna (Fig. 3D). Endopod longer, 0.68 of scale; scale incompletely 3-segmented, with 12 plumose setae and dis-

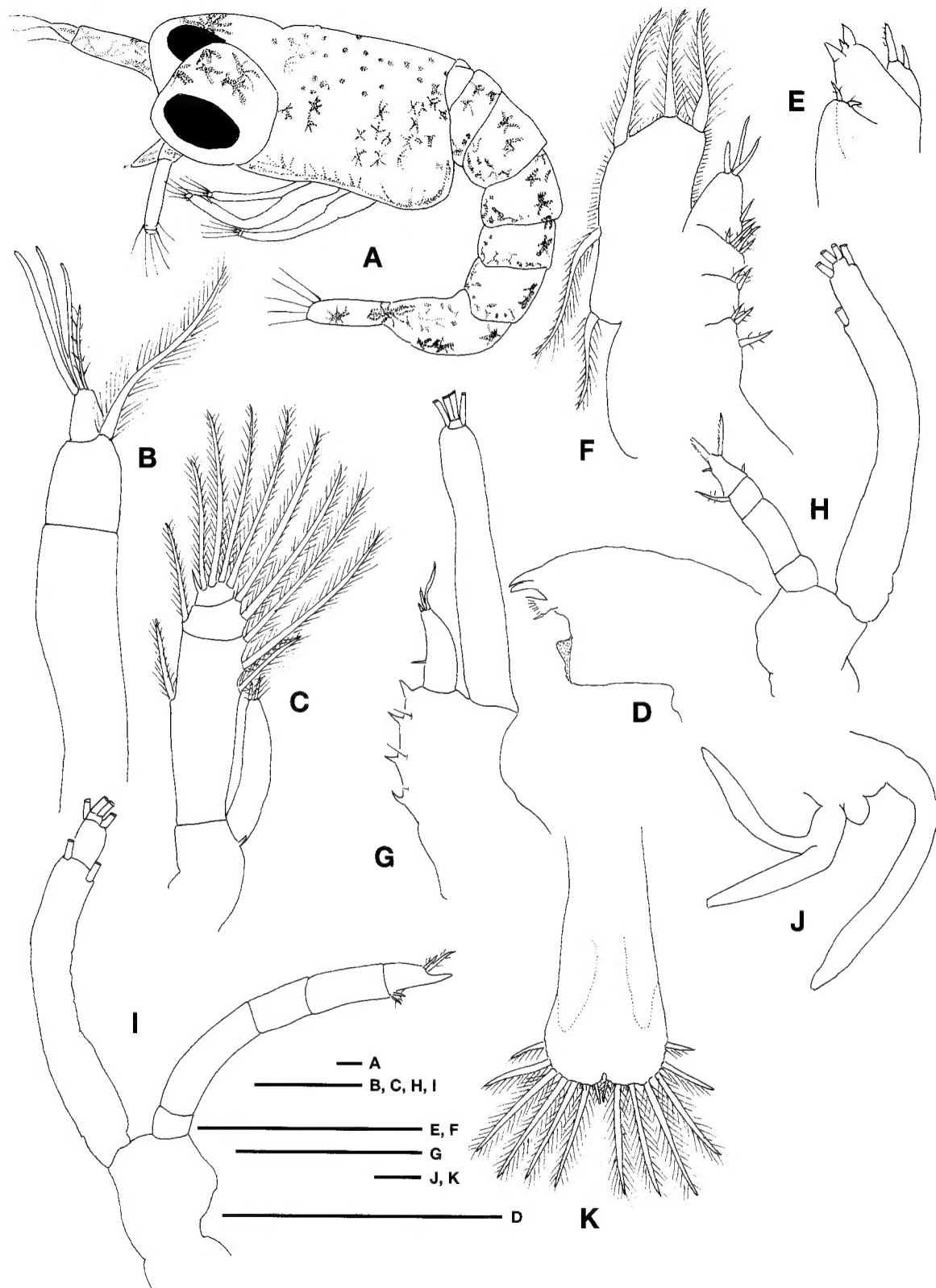


Fig. 1. First zoea of *Synalpheus tumidomanus* (Paulson, 1875). A, habitus, lateral; B, antennule; C, antenna; D, left mandible; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped; J, pereopods; K, telson and uropods. Scale bars =0.1 mm (A-K).

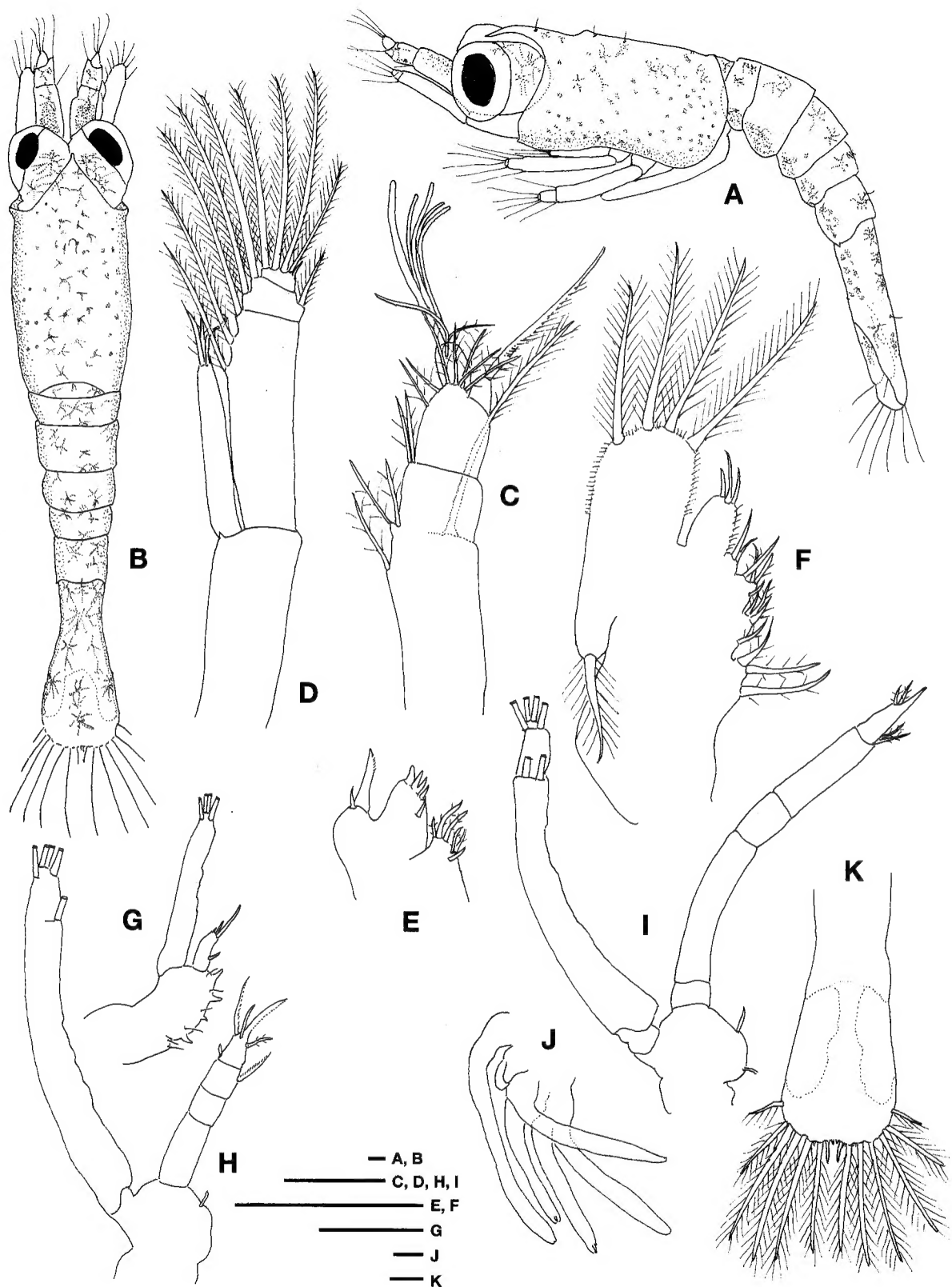


Fig. 2. Second zoea of *Synalpheus tumidomanus* (Paulson, 1875). A, habitus, lateral; B, same, dorsal; C, antennule; D, antenna; E, maxillule; F, maxilla; G, first maxilliped; H, second maxilliped; I, third maxilliped; J, pereopods; K, telson and uropods. Scale bars=0.1 mm (A-K).

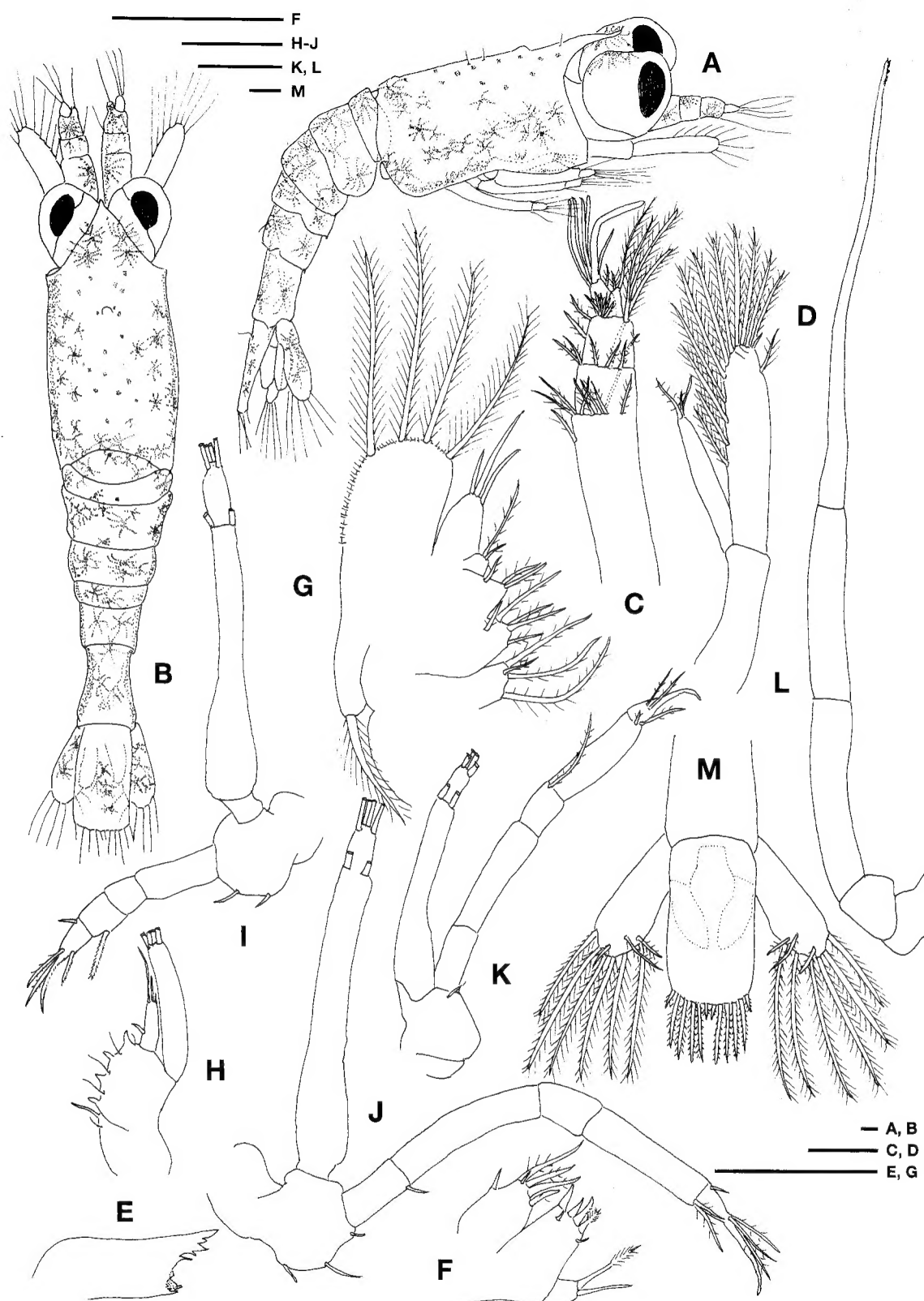


Fig. 3. Third zoea of *Synalpheus tumidomanus* (Paulson, 1875). A, habitus, lateral; B, same, dorsal; C, antennule; D, antenna; E, right mandible; F, maxillule; G, maxilla; H, first maxilliped; I, second maxilliped; J, third maxilliped; K, first pereopod; L, fifth pereopod; M, telson and uropods. Scale bars=0.1 mm (A-M).

Table 1. Morphological characteristics of the first zoeas of *S. tumidomanus* between description given by Bhuti et al. (1977) and that provided by present study.

Characteristics	Bhuti et al. (1977)	Present study
Carapace		
rostrum	present, broad basally, tapering acute, reaching slightly beyond eyes	absent
Antennule		
peduncle	2-segmented, with 6,5 setae	2-segmented, with 0,1 seta
inner flagellum	2 setae	not differentiated
outer flagellum	5 aesthetascs and seta	3 aesthetascs and seta
Antenna		
peduncle	unarmed	distolateral spine
scale	segmented, with 11 plumose setae	3-segmented, with 11 plumose setae and distolateral tooth
endopod	0.67 of scale*, terminating acute spine, with seta	0.5 of scale, with 2 setae
Maxillule		
basal endite	4 spines	3 spines
coxa endite	3 setae	2 setae
Maxilla		
basal endite	4+4 setae	2+4 setae
scaphognathite	7 marginal plumose setae	5 marginal plumose setae
First maxilliped		
coxa	1 seta*	unarmed
basis	7 setae*	4 spiniform setae and 3 hairs
Second maxilliped		
endopod	terminating acute spine, with 4 setae	3-segmented, with 0, 0, 1, 2+1 setae
Third maxilliped		
endopod	2-segmented, with 0, 4 setae	5-segmented, with 0, 0, 0, 2, 2 setae
Telson	outermost one pair plumose only on innerside*	outermost two pair plumose only on innerside
Pereopods		
biramous	first to fourth pereopods	first pereopod
uniramous	fifth pereopod	second and fifth pereopods

*=data from figure

Table 2. Morphological characteristics of the first zoeas between *S. neomeris* and *S. tumidomanus*.

Characteristics	<i>S. neomeris</i> described by Gurney (1927)	<i>S. tumidomanus</i> described in the present study
Antennule		
peduncle	incompletely 3-segmented	2-segmented
Antenna		
scale	segmented	3-segmented
endopod	0.67 of scale	0.5 of scale
Maxillule		
basal endite	1 spine*	3 spines
coxa endite	unarmed*	2 setae
Maxilla		
endopod	1+3 setae*	2+3 setae
basal endite	3+3 setae*	2+4 setae
coxa endite	1+1 setae*	3 setae
scaphognathite	3 apical plumose setae	5 marginal plumose setae
Second maxilliped		
exopod	6 natatory setae	5 natatory setae
Pereopods		
biramous	first to fourth pereopods	first pereopod
uniramous	fifth pereopod	second and fifth pereopods

*=data from figure

tolateral tooth.

Mandibles. Right (Fig. 3E) and left mandibles (not shown)

unchanged.

Maxillule (Fig. 3F). Basal endite with 2 subdistal setae and

4 plumodenticulate setae.

Maxilla (Fig. 3G). Coxal endite with 4 setae; basal endite with 5+4 setae.

First maxilliped (Fig. 3H). Unchanged.

Second maxilliped (Fig. 3I). Basis with 2 setae; exopod 2-segmented, with 2, 4 plumose natatory setae, 4 distal setae symmetrically disposed in 2 pairs.

Third maxilliped (Fig. 3J). Basis with 3 setae; endopod longer, 1.54 of exopod, with 1, 0, 0, 2, 3+1 setae.

First pereopod (Fig. 3K). Coxa unarmed; basis with seta; endopod longer than exopod, 1.73 of exopod, 5-segmented, with 0, 0, 0+1, 2, 2 setae, distal spine present; exopod 2-segmented, with 2, 4 plumose natatory setae, 4 distal setae symmetrically disposed in 2 pairs.

Second to fourth pereopods (not shown). Unchanged.

Fifth pereopod (Fig. 3L). Endopod 5-segmented, unarmed, dactylus elongated, sharply pointed, with 5 distal denticles facing mouthparts.

Abdomen (Fig. 3A, B). Fourth and fifth abdominal somites having pleura with pair of minute posteroventral spines; sixth abdominal somite now differentiated from telson; posterolateral margin acute.

Telson and uropods (Fig. 3M). Telson with 6+6 marginal setae; posterior width almost equal to anterior width. Uropods free; endopod rudimentary; exopod with 6 marginal and 3 submarginal plumose setae.

DISCUSSION

Bhuti et al. (1977) described that the first three zoeal stages of *S. tumidomanus* from Indian waters. However, some morphological characteristics of the first zoeas of *S. tumidomanus* described in the study, particularly on the antenna and telson differ from those of the earlier description (Table 1). Bhuti et al. (1977) described that the peduncle of antennule is unarmed and the scale of antennule has 11 marginal plumose setae. However, present study revealed that peduncle and scale of antennule have distolateral spine and distolateral tooth, respectively. The absence of distolateral spine on the peduncle of antenna and distolateral tooth on the scale of antenna in the description given by Bhuti et al. (1977) may

be due to the previous author's insufficient observation, because they are minute in the first zoeas. Other differences in descriptions can be also seen in the rostrum, the antennule, the maxillule, the maxilla, the first to third maxillipeds, and the pereopods.

There are morphological differences between the first zoeas of *S. neomeris* described by Gurney (1927) and *S. tumidomanus* provided in this study: the segmentation of the peduncle of antennule and scale of the antenna; the length of the endopod of antenna; the setation of maxillule and maxilla; the number of natatory setae of the exopod of the second maxilliped; and the degree of the development of the pereopods (Table 2). The length of the endopod of antennule in *S. tumidomanus* is 0.5 of scale and, thus, shorter than that of *S. neomeris*. The scale of antenna in *S. tumidomanus* is 3-segmented, while it is segmented in *S. neomeris*. Therefore, the first zoeas of *S. tumidomanus* are readily separated from those of *S. neomeris* by the length of the endopod of antenna and the segmentation of the scale of antenna.

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